

THE MEDICAL EVIDENCE IN THE ASSASSINATION OF PRESIDENT JOHN F. KENNEDY

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1. BACKGROUND

1.1. The assassination

Ten years ago, during a motorcade in Dallas, Texas, President John F. Kennedy was assassinated by gunfire before hundreds of horrified onlookers. The President was first seen to clutch at his throat, and then, a few seconds later, his skull was seen to burst. Reports of post-mortem examination later indicated that he was struck by two bullets, the first entering the upper right side of his back and the second entering the back of his head.

Five other persons were seated in the Presidential limousine, which was uncovered at the time. Mrs Kennedy was to the left of the President in the rear seat. John Connally

then Governor of Texas, was directly in front of the President, and Mrs Connally was seated at his left. Two Secret Service agents occupied the driving compartment. Several other vehicles were behind the Presidential car in the procession, the immediate follow-up car containing eight Secret Service agents. ~~to others~~

Governor Connally was severely wounded during the same gunfire. He sustained wounds through the right side of the chest and through his right forearm near the wrist, plus a less severe wound of his left thigh. One of his ribs was shattered, and the radius of his right arm suffered a comminuted fracture. The other occupants of the Presidential car were not hit.

Several photographs and some motion picture films were taken during the assassination sequence, as well as shortly before or after. These, along with the many eye-witness reports and the presence at the scene of numerous federal agents and local law enforcement officers, made the crime one of the most thoroughly observed in history.

1.2. The investigation and the official findings

Investigation by the Dallas Police and the FBI led to an early belief that there was only a single assassin, a man named Lee Harvey Oswald. Oswald was arrested about an hour and a half after the assassination in a theater several miles from the scene, after having purportedly slain a police officer. Oswald himself was murdered two days later while in the custody of the Dallas Police, without ever having admitted any role in either killing.

Several months later, after extensive investigation by the FBI and other government agencies under the direction of a special commission known as the "Warren Commission", the official findings and conclusions were reported to the new President, Lyndon Johnson, and to the American public. In essence, these boil down to a restatement of the early belief reached by the Dallas Police and the FBI: Oswald was the assassin, he had acted alone and unaided, and there had been no conspiracy of any kind, either in the assassination of the President or in the killing of Oswald.

The investigation was massive in scope, and it produced a huge volume of documentation. In addition to its Report, the Warren Commission published 26 volumes of exhibits and the testimony of more than 500 persons. Easily ten times more such materials remain unpublished at the National Archives. Most of them are accessible to the public, although some portions are still withheld.

Yet today, despite the massiveness of the investigation, the precise details of the shooting are still far from clear, and there remain legitimate grounds for doubt that the crime was correctly or fully solved. The Warren Commission itself found it necessary to hedge on some of its most fundamental findings, a fact sometimes overlooked or forgotten by its defenders. In reference to such matters as the number of shots fired, their sequence, and the precise manner in which Governor Connally was wounded, the Commission repeatedly resorted to language expressing uncertainty. Some examples (with emphasis supplied by the authors of this paper) are as follows:

"The weight of the evidence indicates that there were three shots fired."

"Two bullets probably caused all the wounds suffered by President Kennedy and Governor Connally."

"... it was not possible to determine whether the two bullet fragments were from the same bullet or from two different bullets." (This statement is in reference to two mutilated but sizable bullet fragments found in the front of the Presidential car.)

"... there is very persuasive evidence from the experts that the same bullet which pierced the President's throat also caused Governor Connally's wounds. However, Governor Connally's testimony and certain other factors have given rise to some difference of opinion as to this probability..."

Are such uncertainties significant? The answer is that every one of them has an important bearing on the Commission's reconstruction of the shooting and, in conjunction with other evidence, on the crucial question of whether or not it was physically possible for one man to have fired all the shots. The Commission's lone-assassin conclusion cannot logically be more certain than its findings in respect to these details.

Questions of this kind do not arise in the majority of murder cases. Complex plots with multiple participants and contrived deception do not usually merit serious consideration, and the available evidence ordinarily rules them out anyway. But the assassination of a President, with its high stakes for the participants, is a different situation and demands the most careful scrutiny to ensure that "the evidence fits".

The Commission's defenders have tended to be more certain of the official findings than the Commission itself, while its critics have found additional areas of doubt not acknowledged by the Commission. Several of these questioned findings involve medical evidence, or a combination of medical evidence with ballistic, photographic, or other forms of evidence. They relate to the questions of whether or not one person could have committed the assassination and from where the shots were fired. It is with these questions alone, and the medical evidence bearing on them, that this paper is concerned.

1.3. The major areas of doubt involving medical evidence

The question of whether the Governor was wounded by a bullet which had previously struck the President or by an entirely separate bullet was of crucial importance to the lone-assassin conclusion. Although the Commission acknowledged some uncertainty on this point, it also claimed, too glibly, that its theory in this regard was "not necessary to any essential findings of the Commission". The fact is that a motion picture film of the assassination (the so-called Zapruder film) shows convincingly that the initial wounding of the President and the wounding of Governor Connally occurred within a very brief time span, of the order of 1½ seconds at most. This interval is too short by about a second for the firing of two consecutive shots with the particular rifle found at the scene. Tests conducted by the Army and the FBI demonstrated this fact beyond doubt with the actual rifle, and cannot be overcome by tests made with replica rifles.

Hence if the non-fatal wounds of the President and the Governor were not caused by the same bullet, another rifle besides the one found at the scene is necessarily implicated. A bullet and two fragments recovered after the assassination matched the found rifle, but another whole bullet was lost entirely, as the Commission conceded. Therefore the possibility that another rifle was used is not refuted by the ballistic evidence. With another

rifle in use, a second assassin would necessarily have been involved, and the failure to find that other rifle might raise the specter of a still larger conspiracy.

Moreover, the Commission's reconstruction required that a certain nearly whole bullet, designated as Commission Exhibit 399, had inflicted all the non-fatal wounds on the President and on Governor Connally. This bullet was found under puzzling circumstances* at Parkland Hospital in Dallas, where the President and Governor had been taken immediately after the shooting. Its history and chain of possession are far from clear, but the Commission accepted its authenticity and theorized that it had fallen out of Governor Connally's thigh wound at some stage. It is a 6.5 mm Mannlicher-Carcano bullet manufactured by the Western Cartridge Co., consisting of a lead core fully covered, except at the cartridge end, by a substantial copper jacket. In its found state, it weighed 158.6 grains, as compared to an average weight of 161 grains for undamaged test bullets of the same manufacture. Its copper jacket is still fully intact, except for a small notch near the nose end where the FBI removed a sample for spectrometry. In appearance, it is exactly like a cotton-tube test bullet, except for a slight flattening and small loss of lead at its base. Yet by the Commission's reconstruction of the shooting, this bullet is required to have penetrated the upper right portion of the President's body, traversed the right side of Governor Connally's chest (removing several inches of his right fifth rib), pierced the Governor's right arm near the wrist (shattering the distal radius and leaving several particles of lead), and finally to have entered the Governor's left thigh (leaving another metallic particle embedded in his femur), after which, at some unknown time, it fell out. Several years after the assassination, when the photographs and X-rays of the President's autopsy became accessible, other metallic particles were seen in the X-rays of the upper right side of the President's body (unknown to the Commission). There is also some indication of metallic particles in the X-rays of the Governor's chest. While the cumulative weight of all these particles may be less than the weight missing from Commission Exhibit 399**, the larger problem is to explain how an essentially undamaged, fully copper-jacketed bullet could have left them at all, and how the bullet could have caused so much bone damage without suffering substantial surface markings or distortion of shape.

The Commission's findings postulated that all the shots were fired from a certain window on the sixth floor of a building known as the Texas School Book Depository. This building was behind and somewhat to the right of the Presidential car at the time the shots were fired, the distance and angle varying with the position of the car as it moved down the street. The sixth-floor window looked down upon the car at an angle which varied from roughly 20 degrees to 15 degrees over the shooting interval. The street itself curved appreciably and sloped downward from the Depository by a few degrees, making

* The bullet was reportedly found under a stretcher in a remote part of the hospital in the afternoon of the assassination. It was never conclusively determined whether the President or the Governor (or either) had occupied the stretcher.

** The weight of the bullet was no more than 2.5 grains below the average of several unmitigated test bullets. One fragment, from Governor Connally's wrist, alone weighed 0.5 grain.

the calculation of trajectories somewhat involved. Because of the effect of the car's movement on the possible trajectories, the calculations also depend on the times of the shots, and these are not precisely known in the case of the non-fatal wounds of the President and the Governor. Nevertheless, they are known approximately (over a range), and it thus becomes important to determine if the locations and apparent pathways of the wounds can be reconciled with the postulated location of the assassin.

The Commission purported to carry out this calculation with considerable precision, reporting distances to tenths of a foot and angles to minutes of arc, ultimately claiming consistency with the medical data. Closer examination, however, shows this alleged agreement to be specious. There is so much confusion, contradiction, and general vagueness about the locations of the wounds, as known to the Commission, that this part of their calculation is almost meaningless. Lacking accurate data, the Commission relied on an artist's sketch as its authority for the angle of the declination through the President's back/throat wound, reporting that an angle of $17^{\circ}43'30''$ was "approximately" the angle shown in the sketch, when in fact the sketch angle measures less than 10 degrees*. The Commission also claimed satisfactory alignment of this wound with the Governor's chest wound (about 25 degrees downward). Simultaneously, the Commission entirely ignored the problem of reconciling the assumed flight path of the bullet with the angles through the wounds in the horizontal plane.

2. ORIGIN OF THE MEDICAL EVIDENCE

2.1. *The immediate medical treatment*

Immediately after the last shot was fired, the Presidential car was driven to Parkland Hospital in Dallas where the President and Governor were given emergency treatment. The effort to save the President was unsuccessful in the face of the extensive damage to his brain. However, it produced a significant change in the character of one of his other wounds and led to much confusion later.

When the President was examined at Parkland Hospital, he was seen to have a massive head wound, with profuse bleeding and loss of brain tissue, and a much smaller wound in the anterior neck below the Adam's apple. The latter wound was thought to be an entry wound in view of its small size and other characteristics, an interpretation which led to a number of erroneous early news stories about the source of the shots. No other external wounds were noted by the doctors at Parkland, reportedly because the President's body was not turned over for examination of his back.

In an effort to restore the President's breathing, an endotracheal tube was inserted through the neck wound and connected to a respirator. When this proved ineffectual, a tracheotomy was performed to ensure a clear airway. The Parkland doctors also reported the insertion of chest tubes through surgical incisions in the chest.

* The commission's purported measurement of angles to minutes and seconds of arc is absurd. At the supposed range of fire (about 200 feet), one minute of arc corresponds to less than one inch in the position of the rifle.

The tracheotomy incision was made through the anterior neck wound, thus changing its appearance completely and preventing its recognition as a missile wound during the autopsy later that night.

Concurrently, Governor Connally was examined and given surgical treatment for wounds in the right side of his chest, his right arm, and left thigh. Observations of these wounds later played an important role in the Warren Commission's reconstruction of the shooting.

2.2. Circumstances of the autopsy

The President was pronounced dead about one-half hour after admission to Parkland Hospital. An hour or two later, after a dispute in which the Texas authorities were refused their lawful right and duty to perform the autopsy in Texas, the President's body was flown back to Washington, D.C. An autopsy was performed by military doctors that evening at the U.S. Naval Hospital in Bethesda, Maryland.

The circumstances of this autopsy were unusual. At least 30 persons are known to have been present in the autopsy room at one time or another, most of them military. Five were agents of the Secret Service or the FBI.

The members of the autopsy team had had only limited forensic experience at that stage of their careers. Some years afterwards, it was revealed that an Army General, not otherwise identified, had claimed to be in overall charge of the autopsy and that orders had been given not to dissect the President's back/throat wound.

Moreover, it is now known that one roll of film taken during the autopsy was seized from a medical corpsman by a Secret Service agent, who then deliberately ruined the film by exposing it to the light. This incident is not mentioned by the Warren Commission, and there has never been any official explanation for the act.

Under these circumstances, we should not be surprised that a thorough and accurate autopsy was not performed. The decision of the military authorities to rely exclusively on military pathologists, acting under military orders, appears to have been grounded on their concept of the President as Commander-in-Chief of the Armed Forces rather than as Chief Executive of the United States. It produced a seriously defective autopsy.

2.3. The autopsy findings

As ultimately published in the Warren Report, the essential autopsy findings were that the President had been struck by two bullets and that both had been fired from behind and "somewhat" above the President. One of these bullets was reported to have entered the upper right posterior thorax just above the scapula and to have exited from the anterior neck at the midline. The other was said to have entered the skull about 2.5 cm to the right of and "slightly" above the external occipital protuberance, then to have fragmented and erupted through the right parietal region of the skull, carrying with it substantial portions of skull, scalp, and cerebral tissue.

The locations and pathways of these wounds were not precisely reported, and in some instances the reference points for measurements were inept. For example, the vertical

position of the wound in the upper back was measured from the right mastoid process, which is both vague in extent and, relative to other points on the body, subject to variation with changes in posture. The horizontal position of this wound was referred only to the right acromion process, no measurement being given for the distance from the midline of the spine, which was both shorter and more precise. No measurements at all were reported from the top of the head, a commonly used reference point.

During the autopsy examination, the missile wound in the anterior neck was not recognized as such because of the tracheotomy incision. It was discovered only through a telephone call the following day to one of the attending physicians in Dallas. While the failure to recognize the presence of this wound may be rationalized on the basis of the surgical incision, the failure to consult the Dallas physicians before or during the autopsy cannot. Moreover, the failure to dissect and track the back wound is incomprehensible, particularly when the outlet for this wound was not then known.

Inasmuch as the X-rays did not show a whole bullet anywhere in the President's body, and the exit path was not known, the autopsy team resorted to sheer speculation. It was thought that the bullet must have "worked its way out" of the back wound during external cardiac massage. That opinion was noted and reported by the attending FBI and Secret Service agents, who were not present during the telephone conversations and subsequent revisions of the findings on the following day. The FBI agents reported that the bullet which struck the President's back entered at a point "below the shoulders" along a path which was "45 to 60 degrees" downward, and had "no point of exit". Indeed, FBI Headquarters continued to make such assertions as facts for almost two months in its reports to the President and to the Warren Commission, apparently without ever being notified of the corrections. For these and other reasons*, serious questions have been raised as to when the final version of the autopsy report was actually written and what its predecessor versions might or might not have contained. The report itself is undated, although the doctors testified that it was completed on the morning of November 24, 1963.

Several other findings were also reported, including the sizes and appearances of the wounds, descriptions of certain skull fragments, and the disposition of various metallic fragments in the skull as disclosed by the X-rays. In a supplemental report dated December 6, two weeks after the autopsy, the results of microscopic examination of various sections through the formalin-fixed brain are described, as well as sections through the skin at the wounds of entry. *only "entry"? all "entry" is not exist?*

However, certain procedures that would have been invaluable in fully locating and characterizing the wounds were not carried out, or carried out only partially. The wound in the upper back, as already noted, was not dissected. Coronal sections through the fixed brain were not made, although this is a routine procedure in cases of gunshot wounds of

* At least one draft of the autopsy report appears to have been burned. One of the pathologists testified that he destroyed his "preliminary draft notes" in the fireplace of his home on the morning of November 24.

now about eliminating

the head in order to track the pathway of a bullet or bullet fragment. The left side of the brain is described only superficially in the autopsy report, as though the X-ray findings alone were enough to guarantee that no bullet or fragment had traversed it.

As a result, the autopsy failed to provide the detailed and unequivocal findings necessary to settle beyond any dispute the number and general directions of the bullets which struck the President. Nor did it provide the investigative team with any but the most superficial assistance in determining the locations of possible assassins. Instead, the investigation was forced to rely on assumptions and on the recollections of various eye- and ear-witnesses many of which were contradictory and required careful selection. Today, some of the Warren Commission's assumptions and witness selections appear to be wrong in a way which vitiates the Commission's central conclusion that there was only one assassin. A thorough autopsy would almost certainly have avoided this situation.

The autopsy report omits all reference to the adrenal glands. Although this information would not have had any bearing on the assassination whatever, its omission is a clear indication of the degree of control exercised over the autopsy team by the military authorities.

One further illustration of the quality of the autopsy is worth pointing out, although again it is not relevant to any of the Commission's findings. Several of the Parkland Hospital doctors testified that surgical incisions were made into the President's chest. They were quite positive about this, describing in some detail the insertion of chest tubes and connection to equipment. There seems to be no reason for them to have imagined or fabricated these statements. Yet the autopsy doctors testified that the incisions did not enter the chest cavity and that the pleural lining was completely intact. If the Parkland Hospital doctors were correct, what are the implications for the capacity of the autopsy team to find and characterize wounds?

2.4. *The autopsy materials and restrictions on access*

Numerous photographs and X-rays were taken in the course of the autopsy. The Warren Commission declined to examine these, relying instead on the testimony of the autopsy pathologists and a few artist's sketches drawn from oral descriptions of the wounds. The materials were held to be the property of the Kennedy family prior to their donation to the United States Government in late 1966. They are now at the National Archives, but access to them is subject to restrictions imposed by the Kennedy family as a condition on the gift.

Following a rash of public controversy engendered by various books critical of the Warren Report, the photographs and X-rays were reviewed by the autopsy team in early 1967. They reported that the materials corroborated their original findings in all respects.

In early 1968, a second review of the materials was made, this time by a team of four prominent physicians (three pathologists and one radiologist) appointed by Attorney General Ramsey Clark. The report of this review disclosed several observations not previously reported and provided important new details. Chief among these are:

(1) The entry wound in the President's skull was located 25 mm to the right of the

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midline and about 100 mm above the external occipital protuberance, a difference of some three to four inches from its location as reported by the original autopsy team;

(2) A gray brown rectangular structure measuring approximately 13 mm X 20 mm was visible in photographs of the right cerebral hemisphere (the panel was unable to establish its identity); *in X-rays?*

(3) Locations of the President's back and throat wounds are given with some precision and in relation to reasonably well-defined reference points, thus permitting, for the first time, approximate determination of the trajectory of the bullet path;

(4) A large metallic fragment measuring 6.5 mm in diameter, embedded in the outer table of the skull at the lower edge of the entry hole, was seen on the X-rays of the President's head; and

(5) Several small metallic fragments and some subcutaneous emphysema were seen in the lower neck region just to the right of the cervical spine on the X-rays of the upper thorax.

In late 1971, the restrictions on access to the autopsy photographs and X-rays relaxed somewhat to permit non-government pathologists to examine them if approved by the Kennedy family representative. One individual, not a pathologist and not the first to apply for such access, was granted permission in early 1972. One of the authors of this article is the first non-government pathologist given permission to examine these materials, and he conducted his examination on August 23 and 24, 1972.

3. OBSERVATIONS OF THE AUTOPSY MATERIALS

3.1. *The available materials*

The materials examined consist of X-rays, photographs and film negatives from the autopsy, the President's clothing, medical sketches, the bullet and bullet fragments recovered after the assassination, the rifle, the X-rays of Governor Connally, photographs and a diagram of the Presidential car, the Zapruder film and its individual frames, the Nix and Muchmore motion pictures, photographs from the FBI re-enactment of the assassination, and various documentary materials. With the exception of the autopsy X-rays, photographs, film negatives, and clothing of the President, these materials are also accessible to the public.

The X-rays and photographic materials give every indication of being authentic. Their numbers and general descriptions are in agreement with the corresponding data reported by the Ramsey Clark panel, for example, and the facial features, where they can be seen, are consistent with the examining author's recollections of the President.

3.2. *The missing evidence*

Unfortunately, some of the autopsy materials, including some of the most important from the forensic standpoint, are not at the National Archives. We know, for example, that the President's brain was preserved and that several sections were prepared for

microscopic examination. Moreover, certain sections were taken through the skin at the supposed wounds of entry in the scalp and in the upper back of the President. The preserved brain and these various brain and skin tissue sections were examined by the autopsy team about two weeks after the original autopsy, and additional photographs were then made. All of these are described in the supplemental autopsy report published in the Warren Report. Yet, these items — the brain, the microscopic sections, and the supplemental photographs — are all missing from the National Archives.

We also know from the testimony of the original autopsy team that color photographs were taken of the interior of the President's chest cavity. These photographs are important to the determination of the path of the bullet which struck the President's upper back. They are missing also.

All these items had been turned over to the National Archives by Admiral George Burkley on April 26, 1965, according to a memorandum of that date. However, they are not included in the inventory of items officially transferred to the United States Government by the Kennedy family on October 29, 1966. There has been no accounting for these missing items, and there are no known reports of re-examination of them since the original autopsy team examined them in December, 1963.

3.3. The author's observations

The most important of the author's observations are depicted in the accompanying illustrations, with additional details provided in the legends. No attempt has been made, however, to depict the massive head wound of the President in these illustrations. Its appearance is consistent with other verbal descriptions which have been published.

Generally speaking, the author's observations and measurements of the wounds and locations of bullet fragments are in agreement with the findings of the Clark Panel in 1968. However, certain additional observations, not reported by the Clark Panel, are worthy of note:

(1) The unidentified "rectangular structure" seen by the Clark panel in the photographs of the right cerebral hemisphere is perhaps better described as parallelogram-shaped. The precise configuration cannot be ascertained inasmuch as the margins are concealed by overlying brain tissue. It has a slight focal shimmering effect in some pictures, which could be due to photographic artifacts or to light reflection from materials contained within the object. There are no metallic densities visible in the corresponding X-rays which can be readily associated with it, suggesting that its nature is most probably organic.

(2) Color photographs of the back of the head disclose a little flap of skin or other tissue, not easily identifiable, just above the hairline at the base of the skull and slightly to the left of the midline. It has a pale, pinkish red, slightly glistening appearance and is shaped like a small foot with the toes pointing toward the vertex. In one of the photographs, a black line is also visible running from the midportion of the flap to the right occipital-parietal region. It is not possible to determine whether this is a thread of some kind or a line drawn by some person on the negative. The flap itself does not appear to be

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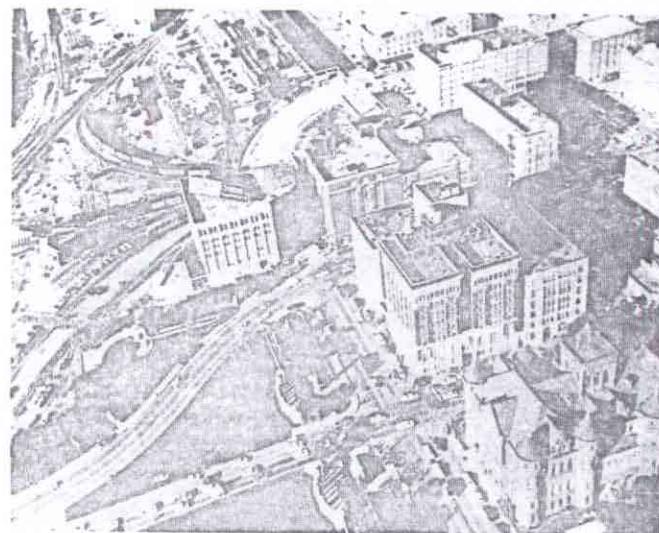


Fig. 1. The Dealey Plaza area in Dallas, scene of President Kennedy's assassination (courtesy, J. Cabnick). North is to the top of the picture in this view. The Texas School Book Depository, location of a lone assassin according to the Warren Commission, is the building with the Hertz sign on top. The street curving downward and leftward from the building is Elm Street, along which the President's car traveled at the time of the assassination. The so-called "grassy knoll" is the area near and to the left of the "pergola", the curved structure overlooking Elm Street. The shots were fired while the President's car was on a path corresponding roughly to the portion of Elm Street directly opposite the pergola. Note that at this location of the car, the Depository building was behind and somewhat to the right of the car. The westerly portions of the building were substantially more to the right of the car than the extreme eastern corner where the Warren Commission placed the assassin.

associated with any underlying wound, and its location does not correspond with any X-ray features or any previous observations by other examiners of these materials.

(3) The wound in the upper back is slightly elliptical, with the longer axis in the horizontal direction, measuring about $5 \text{ mm} \times 7 \text{ mm}$. A darkened, abraded rim around the upper and right margins adds about 2 mm to each of these measurements. The medial margin is between 4 and 4.5 cm from the midline of the back, and the superior margin about 5.7 cm below the lowest crease in the neck. X-rays of this region disclose densities at the right lateral margin of the sixth and seventh cervical vertebrae. The clavicles, ribs, and other bones appear intact. (These observations differ from those of the Clark panel only in respect to slight variations in the measurements.)

(4) The tracheotomy incision is about 1.5 cm wide at the widest part of the gap. There

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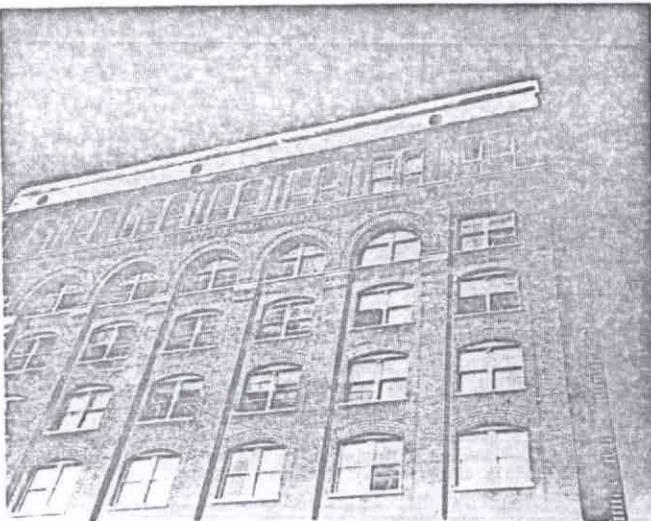


Fig. 2. Photograph of the south face of the Texas School Book Depository Building (courtesy, Mr. Tom Dillard). This photograph, according to the man who took it, was taken within a few seconds after the final shot. The window believed by the Warren Commission to have been the location from which the shots were fired is the partly open window on the extreme right of the floor below the top floor. Note the many other open windows. (Some others off the left edge of the picture are also known to have been open at the time.) Measurements and calculations by the authors indicate that at least two shots were fired from locations substantially further west (leftward in the photograph) of the window specified by the Commission.

is an irregular notch at the midpoint of its lower margin, possibly caused by the endotracheal tube used by the Parkland Hospital doctors. Lack of sharp focus in the photographs showing the tracheotomy prevented the author from identifying and locating the alleged exit wound of the bullet.

(5) X-rays of Governor Connally's chest reveal a number of small particles suggestive of metallic fragments. Although very small, they appear to be metallic. (The report of the Clark Panel gives no indication that these X-rays of Governor Connally were examined by them.)

4. INTERPRETATION OF THE DATA

4.1. *The basic medical data*

Photographs of the President's back wound indicate that its center is located about

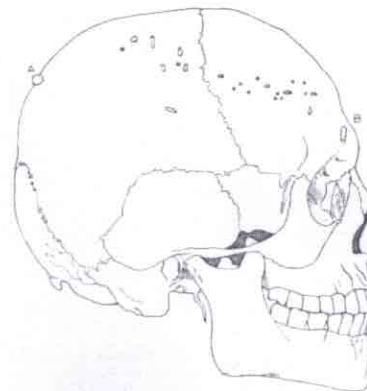


Fig. 3. Approximate locations of metallic fragments seen in lateral X-ray of President's head (skull damage not depicted). Note the sizable fragment at the rear of the skull (A). The location is at the lower margin of the hole of presumed bullet entry. Another sizable fragment is seen in the supraorbital region (B). A fragment from this location is reported to have been removed surgically and later subjected to spectrographic analysis. Smaller particles are very numerous and appear, from this view, to lie along a track in the parietal and frontal regions. This "track" may be somewhat illusory (see sketch of A-P view, Fig. 4). At the time of bullet impact, the President's head was tilted distinctly forward and leftward. Moreover, the exit point of the bullet or its larger fragments cannot be determined because of the large loss of skull bone in the right parietal and frontal regions. The bullet trajectory therefore cannot be determined, although it is clear that the bullet entered from the rear of the President.

4.5 cm to the right of the midline of the spine and about 6 cm below the lowest crease in the back of the neck. Accepting that this wound lines up with an exit hole in the midline of the throat at the level of the third or fourth tracheal ring, the path length of this wound is approximately 15 cm. Adopting also the Clark Panel's measurement of the vertical position of the exit hole, namely 9 cm below the same crease (although the author was unable to corroborate this measurement from his own observations), we are able to compute the trajectory of the bullet relative to the horizontal and sagittal planes through the President's body at the time he was struck.

The downward angle works out to be 11½ degrees, and the lateral angle (from right rear to left front) is 17½ degrees. Allowing for a potential 0.5 cm error in the measurements of these wound locations, the possible variation in these calculated angles is about 2 degrees, either plus or minus. Thus the bullet which struck the President's back entered at an angle of from 9½ to 13½ degrees downward relative to the horizontal plane, and from 15½ to 19½ degrees right-to-left relative to the sagittal plane. The corresponding angles relative to the fixed surroundings would, of course, depend on the orientation of the car and the posture of the President's body at the time he was struck.

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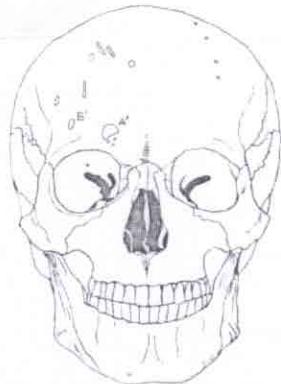


Fig. 4. Approximate locations of metallic fragments seen in A-P X-ray of the President's head (skull damage not depicted). The sizable fragments (A' and B') seen above the right orbit appear to correspond to those noted in the lateral X-ray at the rear and front of the skull. In this view, the smaller particles appear widely dispersed laterally, suggesting that the "track" seen in the lateral X-ray may be somewhat of an illusion caused by lack of depth perception. This shows the need for sectioning of the brain. Note that a few very small particles are visible even on the left side of the President's head. There is the appearance of a very small particle on the right side of the mandible near the midline. No density corresponding to this location is seen on the lateral X-ray. Its location could be in the region of the spinal column and thus relate to the President's back wound.

The pathway of the bullet which struck the President's head is not amenable to the same kind of calculation. This bullet fragmented, and the point or points of exit of the fragments are not known with any precision. Nor, because of the bone impact and fragmentation, is it likely that the bullet fragments followed a course in line with the original flight path. Because of the extensive loss of skull, it cannot be absolutely ascertained that no more than one bullet struck the President's head, at least from the available autopsy photographs and X-rays. However, one entry wound is definitely identifiable, and its location high on the rear of the skull points to a rearward location for the source of the shot.

The data on the wounds of Governor Connally establish that he was struck by a bullet which entered the far right side of his back near the axilla, the corresponding exit wound being in the right chest just below the nipple. Photographs of the Governor's suit coat show a hole in the back, corresponding to the entry wound location, which is appreciably elongated in the horizontal direction. Angular measurements on this wound as reported by witnesses before the Warren Commission estimate that the bullet was on a downward angle of 25 degrees and a right-to-left angle of 20 degrees relative to the appropriate planes through the Governor's body. A portion of the fifth rib on the right side was shattered by this bullet.

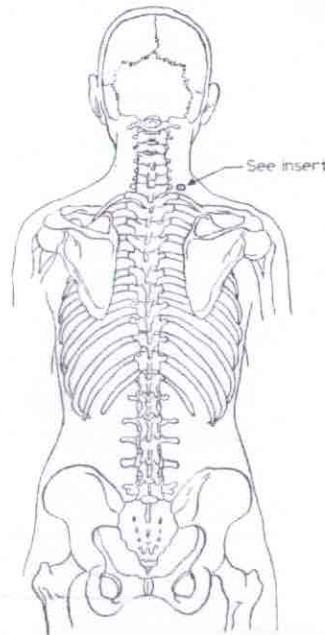
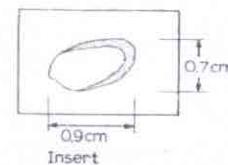


Fig. 5. Approximate location of the wound in the President's back. The insert shows an enlarged view of the wound with its approximate dimensions. The border of the wound shows a darkened, abraded rim, varying from 0 to 2 mm wide, most noticeably along the lateral margin. This abraded rim is typical of a bullet striking at an appreciable angle off the perpendicular at the point of entry. In this case, the implied direction is primarily from right to left. This direction is also consistent with the reported location of the exit wound at the midline of the anterior throat and the fact that the knot of the President's tie was apparently grazed along the left side as the bullet emerged. X-rays of this region of the President's body disclose metallic particles to the right of the sixth and seventh cervical vertebrae.

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The Governor's right arm was penetrated near the wrist, the bullet or missile entering the back side 5 cm above the wrist joint and exiting from the palm side about 2 cm from the crease of the wrist. The right radius suffered a comminuted fracture with deposition of several particles of lead.

The Governor's left thigh received a puncture wound in the medial aspect of the distal third, with a small metal fragment revealed by X-rays to be embedded in the femur.

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As noted previously, metallic fragments were also seen in X-rays of the President's upper back and neck region and in X-rays of Governor Connally's chest, although they are not reported by the Warren Commission. *Connally 6461*

4.2. Relevant collateral data

In addition to the nearly whole bullet recovered at Parkland Hospital and subsequently designated as Commission Exhibit 399, numerous bullet fragments were recovered. Two large fragments, Commission Exhibits 567 and 569, were found late on the night of the assassination in the front seat of the Presidential car. These weighed 44.6 and 21.0 grains respectively, the larger fragment consisting of both lead and copper while the smaller consisted of copper alone. The two together aggregated less than one-half of a whole bullet, and it was never determined whether they originated from one bullet or from two separate bullets. *3 from back seat?*

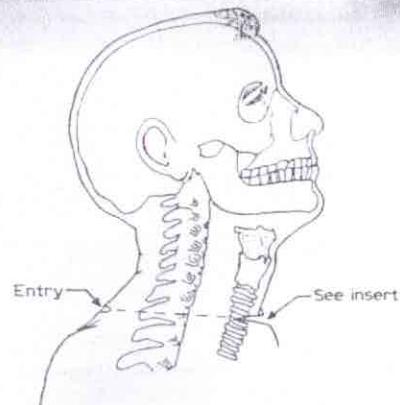
Other, much smaller, fragments were removed from the President's brain, from Governor Connally's wrist, and from the carpet on the floor of the Presidential car near where Governor Connally and Mrs Connally were seated. In addition, metallic smears were noted on the inner surface of the windshield of the car and on a street curb in the general vicinity where the assassination took place. All of these smaller fragments and smears together aggregated only about 5 grains. All were identified spectrographically as lead.

The nearly whole bullet and the two large fragments were examined microballistically and found to have been fired by the same rifle, a 6.5 mm Mannlicher-Carcano reported to have been found on the sixth floor of the Texas School Book Depository, a building near the scene of the assassination. Three cartridge cases found near a window of the same floor were also determined to have been fired in this rifle.

Motion pictures taken during the assassination show that when the President received his head wound, his head was momentarily driven forward about two inches. About one-ninth of a second later (two frames of the film), his head begins a backward and leftward movement, along with the upper part of his body, until he has fallen over to the left side of the car. The moment of bullet impact is clearly visible on the film because of the eruption of brain tissue and fluid in that particular frame. A kind of pinkish mist is visible near the President's head for several frames of the film, ultimately fading away. No such impact or eruption is evident in any other frame of the film.

Reactions to other wounds of the President and Governor Connally are also evident in the films, but the precise times when the wounds were inflicted do not appear to be determinable. However, Governor Connally's reaction is clearly seen to occur later than that of the President by an interval of at least one-half of a second, and possibly as long as one and a half seconds. Tests of the Mannlicher-Carcano rifle found at the scene have established that it cannot be fired twice consecutively in less than 2.3 seconds, even without allowing for the time required to reposition and re-aim the rifle at a moving target.

Governor Connally was seated directly in front of President Kennedy in the Presidential car. Diagrams of the car show the separation between the seats, back to back, to be about



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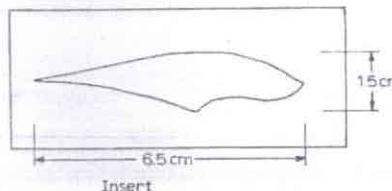
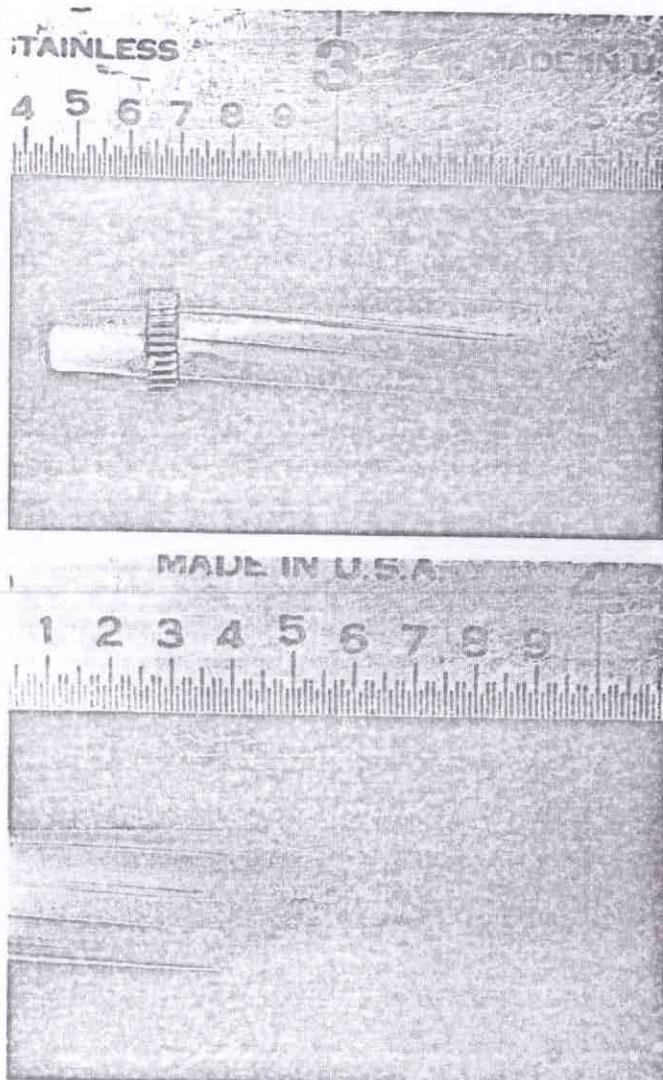


Fig. 6. Schematic representation of the locations of the wounds in the President's back and throat. The presumed entry wound is about 6 cm below the lowest crease in the back of the neck. The tracheotomy incision (see insert) is at about the level of the third and fourth tracheal rings (the thyroid gland is not shown in the sketch). The indicated pathway of the bullet is downward (about 3 cm over a distance of 15 cm), yielding an angle of 11 or 12 degrees, whereas the Warren Commission, without actual measurement of the wound itself, postulated a flight angle of about 18 degrees (after correcting for a 3-degree slope of the street).

30 inches, so that the horizontal distance from the President's throat to the Governor's back would be of the order of 24 inches. The Governor's seat was three inches lower than the President's at the time of the assassination, according to Secret Service agents who examined the car, but this difference is partially canceled out by the fact that the Governor was about two inches taller.

On-site measurements and re-enactment tests by the FBI established that during the interval when the President and Governor could have received their non-fatal wounds, the

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suspected assassin's site (sixth-floor window) looked down on the Presidential car at an angle which varied from 22 to 20 degrees as the car receded; the corresponding right-to-left lateral angle, relative to the longitudinal axis of the car, varied from about 12 to 8½ degrees. The street over this interval slopes downward (away from the suspect window) by about 3 degrees.

Motion pictures and still photographs taken just before or during the early portion of the interval when the President and Governor could have received their non-fatal wounds show both men to have turned their heads to the right, but that the upper parts of their

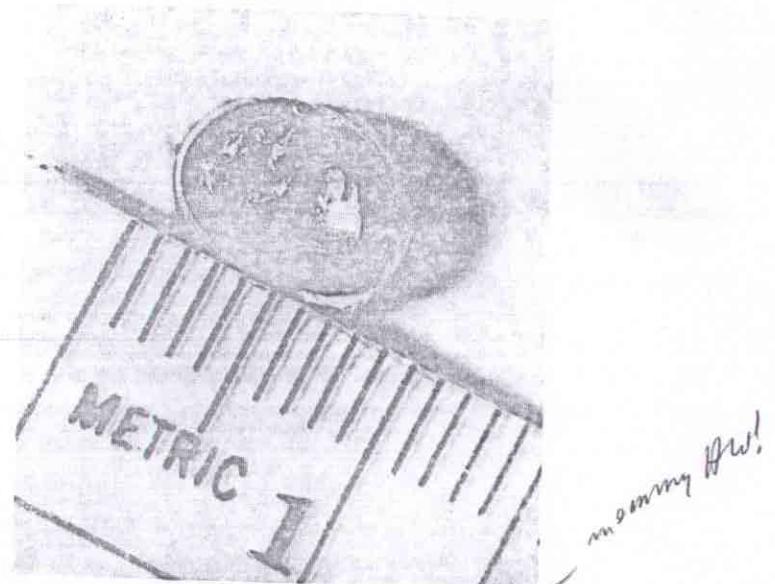


Fig. 7. Three views of Commission Exhibit 399 (courtesy, National Archives). The Warren Commission postulated that this bullet penetrated the President's upper back and lower neck, traversed Governor Connally's chest (shattering a rib), then pierced his right arm near the wrist (shattering the radius), and finally entered his left thigh, depositing a metal particle in the femur. Metal particles have been seen in X-rays of all these wound sites, one in the Governor's wrist having been removed and found to be lead weighing half a grain. Yet the bullet is undeformed except for the flattening of the base, and its weight is at most only 2½ grains less than that of undamaged test bullets fired from the same gun. Aside from artifacts (inscription of initials by FBI agents and the removal of a specimen for spectrographic analysis), the surface of the bullet is unmarked. Its copper jacket is still intact, showing that the only place where lead could have been lost is from the base of the bullet. The authors reject the Commission's theory as to the wounds caused by this bullet.

Connally was - body turned

bodies are not turned or tilted from their normal erect positions. Turning of the head alone does not change the positions of the wound sites involved.

The President's tie showed a distinct abrasion of the outer fabric where the knot had been tied. Photographs and reports establish that the abrasion was on the left side of the knot as worn by the President.

4.3. Evaluation and judgment

Commission Exhibit 399, the bullet which was believed by the Commission to have caused all the non-fatal wounds in President Kennedy and Governor Connally, shattering two bones in the process, shows no deformity (other than an FBI artifact) on its nose or anywhere in the upper two-thirds of its length. The lower third, though it shows some flattening and a small loss of lead at the base, has no impact marks on its surface. Moreover, the completely intact copper jacket of the bullet is entirely inconsistent with the observation that all four wound sites show depositions of metallic fragments. This is not the appearance of a bullet which has struck and fractured two bones, particularly Governor Connally's right radius. A bullet that had caused such damage would have been much more deformed and mutilated, would have shown clearly visible surface markings, and would have lost substantially more substance than the 2 to 2½ grains estimated by the FBI.

On these grounds, we reject the Commission's hypothesis as incompatible with experience. It should be pointed out, however, that these grounds do not entirely eliminate the possibility that some lesser combination of wounds (not including the wrist wound of Governor Connally) might have been caused by the bullet in question, or that some different bullet (not recovered or possibly not recognized among the fragments) may have caused them.

When we examine the indicated trajectories of the wounds and the bullet flight paths required by the Commission's hypothesis, other major obstacles arise. According to the Commission's theory, a bullet entered the upper right side of the President's back and emerged at the midline of the anterior throat, grazing the left side of the knot of the President's tie as it emerged. Thereafter, this bullet is said to have entered the far right side of Governor Connally's back near the axilla and then to have traversed his chest, exiting just below the right nipple.

Governor Connally was seated directly in front of the President. Motion pictures and still photographs taken at the time or just before these body wounds were inflicted show no indication that either man's body was appreciably turned, tilted, or displaced relative to the car or each other*. The lateral angle of the wounds, relative to the longitudinal axis

* The Governor's body is turned when he first emerges from behind a sign as seen in the Zapruder film, and he makes further turns in subsequent frames, exactly as he testified to the Commission. But by this time the film clearly shows that the President has already been hit and is making voluntary movements in response to his wounds.

of the car as the men were seated, is approximately the same for both men, 17½ degrees for President Kennedy and 20 degrees for Governor Connally, the bullet moving from right to left as it traversed forward. The Commission's theory therefore requires that the bullet, just after leaving the President's throat and grazing the left side of the knot of his tie, make an acute angular turn to the right in mid-air in order to enter the far right side of Governor Connally's back. Bullets have been known to take inexplicable pathways in bodies, but they do not make spontaneous sharp turns in mid-air. The theory that one bullet caused both the President's back/neck wound and the Governor's chest wound is therefore untenable.

It should also be pointed out that the indicated pathways of these wounds are in considerable disagreement with the calculated trajectories from the postulated firing position of the assassin. The supposed assassin's site looked down on the car at an angle which varied from 22 to 20 degrees in the vertical plane and from 12 to about 8 degrees (right to left) in the horizontal plane, during the time interval over which these wounds might have been inflicted. The slope of the street, about 3 degrees, might perhaps be deducted from the vertical angle if we assume that the men's seating posture was determined by the slope of the car rather than their own sense of balance. (The Warren Commission made this correction although it is open to some question.) However, the vertical angle through the President's back/neck wound measures only about 11½ degrees, while that through the Governor's chest is larger, namely about 25 degrees. The indicated lateral angles (right to left in the horizontal plane) are about the same for both men, namely about 20 degrees*. While these angular measurements are subject to error of a few degrees either way, the discrepancies seem too large to explain away in this fashion.

We now have three major objections to the Commission's "single-bullet theory", namely the near-pristine condition of Exhibit 399, the impossibility of the bullet flight path from the President's throat to the right side of the Governor's back, and the large discrepancies between the wound angles and the postulated firing trajectories. To these could be added the visible difference in the times of reaction by the two men as seen in the Zapruder film and Governor Connally's own testimony that he believes he was hit by a separate shot.

However, it is clear that both men were hit within a very short time interval, not over 1½ seconds. Since the rifle found at the scene could not be fired twice consecutively in less than 2.3 seconds, another rifle is required to account for one of the shots. Presumably the ballistic evidence from that other rifle was not recovered, nor was the rifle itself. This is not at all implausible, considering the confusion that ensued at the scene immediately after the assassination. The Warren Commission itself, having concluded that three shots were fired, was forced to concede that one whole bullet was lost, since the bullet and bullet fragments recovered aggregated only 1½ bullets altogether. The Commission

* The fact that both wounds were inflicted at substantial lateral angles is also supported by the horizontal elongation of the President's back wound and of the hole in the back of Governor Connally's suit coat.

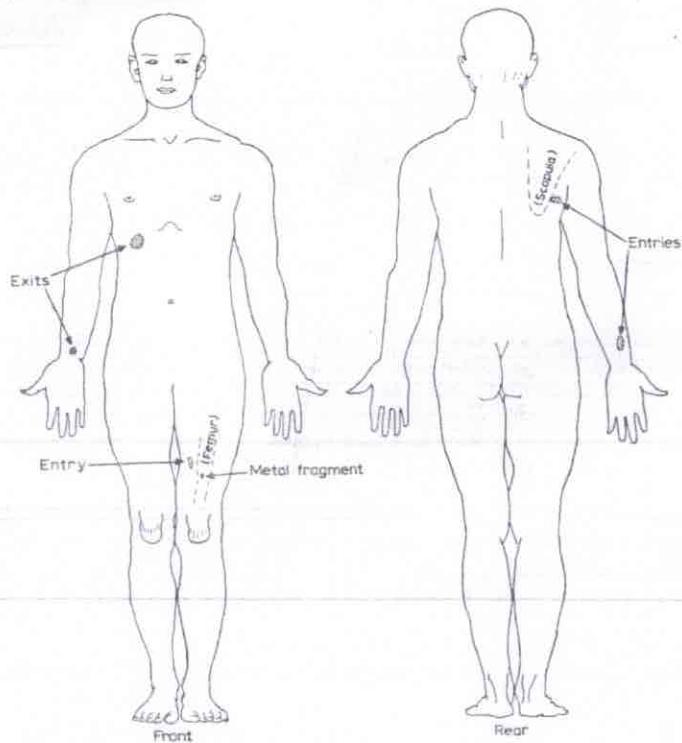


Fig. 8. Locations of Governor Connally's wounds.

Note conflict with DPW?

postulated that the missing bullet missed the Presidential car and its occupants entirely. In the absence of that bullet, there can be no microballistic examination to determine what rifle fired it.

The wound angle data from the President's back/neck wound and Governor Connally's chest wound suggest very strongly that both guns were fired from a position considerably further west in the Texas School Book Depository than was thought to be the location of the assassin. The size and position of this building, relative to the Presidential car at the time of the assassination, is entirely compatible with this judgment. Moreover, the angles of the wounds in the *vertical* plane suggest that President Kennedy's wound was inflicted by a bullet fired from a low or intermediate floor, while Governor Connally's was inflicted by a bullet fired from a high floor or possibly the roof.

THE ASSASSINATIONS

The available evidence, assuming it to be valid, gives no support to theories which postulate gunmen to the front or right-front of the Presidential car. The wound in the President's head, as evidenced in the autopsy photographs and X-rays, can only have been fired from somewhere to the rear of the President. However, it cannot be determined whether this shot was fired from the same location or locations as the shots which caused the non-fatal wounds. If any other bullet struck the President's head, whether before, after, or simultaneously with the known shot, there is no evidence for it in the available autopsy materials.

The absence or unavailability of certain evidence in this case leaves a number of residual doubts and unexplained mysteries. The missing evidence includes several autopsy items — the preserved brain tissue slides, including sections of brain and of skin at the wounds of supposed entry, and several photographs of the chest cavity — and the analytical data from the FBI's laboratory examination of the bullet and bullet fragments. All of these items are known to exist, or to have existed at one time. Their continued withholding leaves important questions unanswered and is a disservice to the nation.

For example, the detailed data from the spectrographic analysis and from the neutron activation analysis of the bullet, Commission Exhibit 399, and the various bullet fragments and lead particles recovered, could settle a number of questions important in reconstructing the shooting. For example, is the lead fragment removed from Governor Connally's wrist of the same composition as the lead in Commission Exhibit 399 or is it not? Does its composition match that of any other fragment recovered, e.g. one of the large fragments found in the front of the car? Is the copper in the two large fragments found in the front of the car from the same bullet or from two different bullets? From what bullet or fragment did the lead found on the inside of the windshield originate? Or the lead smear found on the street curb in the vicinity? Are there any fragments or particles whose composition indicates a different manufacturer from the others? Such questions can be answered by good analytical work, and in a case so fraught with difficulties in explaining the shooting, there can be no legitimate excuse for not providing the results of the tests already performed and for not conducting other appropriate scientific tests which might well resolve these questions conclusively.

5. SUMMARY AND CONCLUSIONS

5.1. Autopsy conditions and procedures

The autopsy of President Kennedy was deficient in failing to report a number of important facts about the nature of the President's wounds and in neglecting to make accurate measurements of the locations of the wounds. At least one serious oversight occurred in respect to a wound in the President's throat, which oversight was not corrected until the following day, after belated consultation with doctors who treated the President in Dallas.

The autopsy was completely dominated by military personnel under military orders.

Instructions were given to the autopsy doctors which prevented the performance of important procedures, such as dissection of an observed wound in the upper back and the sectioning of the brain.

Too many extraneous personnel were in attendance, while highly qualified civilian forensic pathologists, who might have ensured a thorough autopsy, were deliberately not invited.

5.2. Governmental handling and disclosure of evidence

The Government's handling of the evidence in the case created much unnecessary confusion and skepticism. The FBI itself was unaware, for almost two months as reflected in their official reports, that the autopsy team had corrected itself the day after the autopsy and concluded that a bullet had exited from the President's throat. Photographs and X-rays of the President's body were not examined by the Warren Commission, and instead reliance was placed on artist's sketches and verbal descriptions which were later found to be in error.

After the Warren Report was published, the Government continued to withhold fundamental medical and other evidence. The autopsy photographs and X-rays have been kept secret from the public and, until recently, they have even been withheld from qualified, independent, non-government pathologists.

Important analytical data concerning the bullet and bullet fragments continue to be withheld. The data could settle a number of critical questions about the details of the shooting; the data are known to have been acquired by the FBI laboratory, but there is no indication that the Warren Commission ever saw them or even asked for them.

Certain important autopsy materials, including the preserved brain, certain tissue and skin sections, and several photographs are unavailable and unaccounted for.

5.3. Present state of knowledge of the details of the shooting

The Warren Commission's "single-bullet theory" is untenable, and the Commission's conclusion that there was only one assassin cannot be reconciled with available evidence. Medical and photographic data, including measurements of wound angles and calculations of bullet trajectories, strongly suggest that there were two rifles used. The indicated locations are in the same building concluded by the Warren Commission to be the site of a lone assassin, but at points further west in this building and on two different floors.

So far as the available medical evidence shows, all shots were fired from the rear. No support can be found for theories which postulate gunmen to the front or right-front of the Presidential car. The medical evidence indicates that the President's back was hit by one bullet and that his head was hit by one other bullet only.

Residual doubts exist about the details of the shooting. At least some of these can be cleared up by making all of the autopsy materials available, and by releasing the detailed FBI laboratory data on the spectrographic and neutron activation analyses of the bullet and bullet fragments recovered.